MATHEMATICS IN METEOROLOGY.

The magnificent mathematical work on the motions of the atmosphere, by Prof. F. H. Bigelow, published in the second volume of the Report of the Chief of the Weather Bureau for 1898–99, and the similar studies by other eminent mathematical physicists, such as those by Diro Kitao, of the Agricultural College in Tokio, by von Bezold and von Helmholtz in Berlin, Margules in Vienna, Hertz of Kiel, Oberbeck at Tübingen, Guldberg, and Mohn at Christiania, and Ferrel at Washington, must impress every student of meteorology with the desire to master the mathematical methods that have led to these brilliant results. It is impossible to confine meteorology to mere observation, telegraphy, and charting. Even the observational exploration of the upper air by kites and balloons and by the study of the clouds does not wholly respond to the demands of the situation. Back of the facts there must be reasons why, and these laws constitute meteorology. The forecaster stands in the presence of a complex problem in mechanics that must be solved by the methods introduced into the study of mechanics by Sir Isaac Newton and developed by a host of devoted experts, such as Poisson, Laplace, Jacobi, Lagrange, Maxwell, Helmholtz, and such living authorities as H. Poincaré, Kelvin, Klein, Rayleigh, J. J. Thomson, Heaviside, and others too numerous to mention. In the October number of the MONTHLY WEATHER REVIEW we have recently published a paper by Prof. V. Bjerknes that presents one of the simplest problems in a manner that is as elementary as is any way possible, consistent with the exact discussion of the subject; but in the application of his ideas, and especially in an effort to understand their rationale, one has to call to mind mathematical formulæ that are only found in the higher text-books of mechanics and mathematical physics. Although the majority of the readers of the MONTHLY WEATHER REVIEW will look askance at these formulæ and wonder if they are really necessary or merely a pedantic show of learning, yet, those who have any true comprehension of the problems will recognize that they can not be dispensed with, and that those to whom they seem incomprehensible must study the higher mathematics if they intend to keep up with the highest progress in our science. About 1877 the Editor translated a number of short memoirs that will be found in the Report of the Secretary of the Smithsonian Institution intending them as a guide and convenience to American students. In 1891 he prepared another collection of translations, published also by the Smithsonian Institution as The Mechanics of the Earth's Atmosphere. There are many more papers of great value still awaiting publication. All this has been done that American students might be left without excuse if they neglect the fundamental study of the atmosphere. The Editor's hope has been that the seed thus sown would in some few cases fall upon good ground; that some universities would give mathematical meteorology as prominent a place as they do mathematical astronomy; that some professors and students would take up the subject in earnest, and that Americans contributing to these higher studies might achieve equal distinction with that attained in observational work and in practical forecasts. These publications must be looked upon as paving the way for the meteorology of the future, when it will be as much superior to that of the present as the present astronomy is superior to that existing before Newton's day.

A friend has lately expressed the desire that the MONTHLY WEATHER REVIEW should publish a series of articles explaining what mathematical and physical training is required if a man would fit himself to become a working meteorologist. Probably, by working meteorologist is meant an observer and forecaster, and, therefore, the reply must be that he should understand the sources of error of his instruments and the methods of investigating their errors. This implies pretty much everything that is taught in the undergraduate courses of schools of science as to algebra, plane and solid geometry, plane and solid trigonometry, theory of errors, mechanics of solids and fluids. If now this working meteorologist and forecaster is to understand the errors of distortion on the maps and charts of the world that he has to use instead of a sphere, then, he must understand projections. If he is to understand and interpret the phenomena of the rainbow, the halo, etc., he must study optics or the theory of light. If he is to understand the action of moisture in the atmosphere and the formation of rain, snow, and hail, he must conquer thermodynamics. If he is to understand the motions of the atmosphere he must study hydrodynamics and the theory of equations.

Now all these matters are taught in all first-class schools of engineering, so that the difficult science of meteorology requires but little more fundamental learning than is required of electrical or hydraulic or steam engineers, but it certainly requires every bit of that. One may study these subjects year after year while supporting himself by his regular work on station, but of course it is better to have acquired them in college beforehand. It is not to be supposed that many will have the intellectual gifts requisite for this work, but no one can tell beforehand to how high a degree he may attain by persistent work. Professor Ferrel's life was one continuous study and advance. Attack the problem and you will succeed in proportion to the earnestness of your attack. The successful man is the one who perseveres.

A MEMORABLE STORM OF SLEET AND SNOW.

We publish on Plate I, figs. 1 and 2, two half-tones from photographs kindly furnished by R. G. Allen, Section Director, Ithaca, N. Y., illustrating the great damage done on November 22–24 in the highlands of western New York by the heavy fall of snow and sleet. On this point the Herald, of Hammondport, says:

> The falling moisture clung to and froze fast upon everything. Nearly every fruit orchard was more or less damaged, and some were totally ruined. Thousands of trees were either uprooted or thoroughly stripped of branches. Whole tracts of forest were similarly affected, in many instances being crushed to the ground, * * * Fruit trees of almost every description were more or less damaged. Young orchards escaped with slight injury, from the fact that the weight bent the trees to the ground, thus saving them. It is said that one and one-half inches of ice formed on every twig and branch of the trees. This will give a faint idea of the immense weight. One man says that in a tract of second growth hickory and white oak from thirty to fifty feet tall, the trees were bent entirely over, the tops resting on the ground. When the sun loosened the ice many sprung back, but portions of them were splintered and ruined. The drippings from pine boughs formed in many instances complete thatched roofs. Pine timber was, therefore, less injured than others, from the fact that all of the pine boughs were so closely bound together that the weight was more equally distributed.
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> One of the strange sights of the effects of the storm was that upon wire fences. In many cases they were one solid sheet of ice, with scarcely a crevice large enough for a field bird to penetrate. The amount of damage can hardly be estimated but it will be immense at the best. In the memory of the oldest inhabitant nothing like it has ever been known in this region. The result will be a great scarcity of apples and other fruit for years to come in the region thus affected.

HURRICANES AT CHARLESTON, S. C.

In a review of the past century published in the Charleston, S. C., News and Courier, of January 1, 1901, there is given a catalogue of the various hurricanes and other meteorological events of interest, from which we take the following dates:

Plate I.—Views illustrating the damage done by storm of November 22, 1900, near Ithaca, N. Y.

Fig. 1.

Fig. 2.